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# OPTIMAL SELECTION OF MULTIVARIATE FUZZY TIME SERIES MODELS TO NON-STATIONARY SERIES DATA FORECASTING

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Abstract. *This paper links testing of non-stationary time series features to the selection of fuzzy model for time series prediction. The data for model test are obtained from AREMOS, Taiwan. Empirical results show that fuzzy time series models have different performance patterns in predicting non-stationary time series. Data with a clear time trend, such as consumption, exports or other macroeconomic data, are best predicted with a Heuristic model. For data with significant oscillations, financial indices, such as a futures index, a Markov model performs best. A Two-factor model produces the most accurate predictions for series that need to be differenced twice to become stationary. The results provide the fuzzy models a beneficial reference for an effective use of time series prediction.*

**Keywords:** Multivariate fuzzy time series, Two-factor model, Heuristic model, Markov model

1. **Introduction.** The world is experiencing a data explosion, and there is an urgent need for ever more accurate methods of time series to improve the accuracy of predictions based on existing data. There are many examples in the literature of excellent predictive techniques, often involving the combination of methods from different fields, e.g. Wakuya [1] and Tamura *et al.* [2]. There are also analyses which begin with an investigation of the features of the data itself, for example Basha and Ameen [3], and it is this approach that informs this paper.

Time series data can be stationary or non-stationary. Non-stationary time series are regarded as particularly important because many economic variables are non-stationary. These include important macroeconomic indices such as incomes, prices, interest rates, consumption, and some finance indices. With non-stationary variables, there is a major problem of spurious regression, as discovered by Granger and Newbold [4]. Since their discovery, it has been recognized that data must be tested for stationary. The most common tests are unit root tests. Where a variable is confirmed to be non-stationary, it is differenced to generate a stationary series, and then fit to a suitable model (e.g. ARIMA).

However, the traditional time series models used for prediction are linear, and not applicable to nonlinear data or to fuzzy data. The problem of fuzziness is common. Many kinds of data appear to be precise figures, but in fact each data point is only one instantiated value from a range of possibilities. Stock prices are an example: when